



# Pipeline Design & Construction

Step by Step





# 195.401 General requirements (Subpart F)

(c) Except as provided in 195.5, no operator may operate any part of any of the following pipelines unless it was ***designed*** and ***constructed*** as required by this ***part***:

§195.5 Conversion to service subject to this part.



# 195.401 General requirements (Subpart F)

(c)

☐(1) An interstate pipeline, other than low-stress, on which construction was begun after **March 31, 1970**, that transports hazardous liquid.



# 195.401 General requirements (Subpart F)

(c)

- (2) An interstate offshore gathering line, other than low-stress, on which construction was begun after **July 31, 1977**, that transports hazardous liquid.





# 195.401 General requirements (Subpart F)

(c)

■ (3) An intrastate pipeline, other than low-stress, on which construction was begun after **October 20, 1985**, that transports hazardous liquid.

■ (4) A pipeline, on which construction was begun after **July 11, 1991**, that transports carbon dioxide.



# 195.401 General requirements (Subpart F)



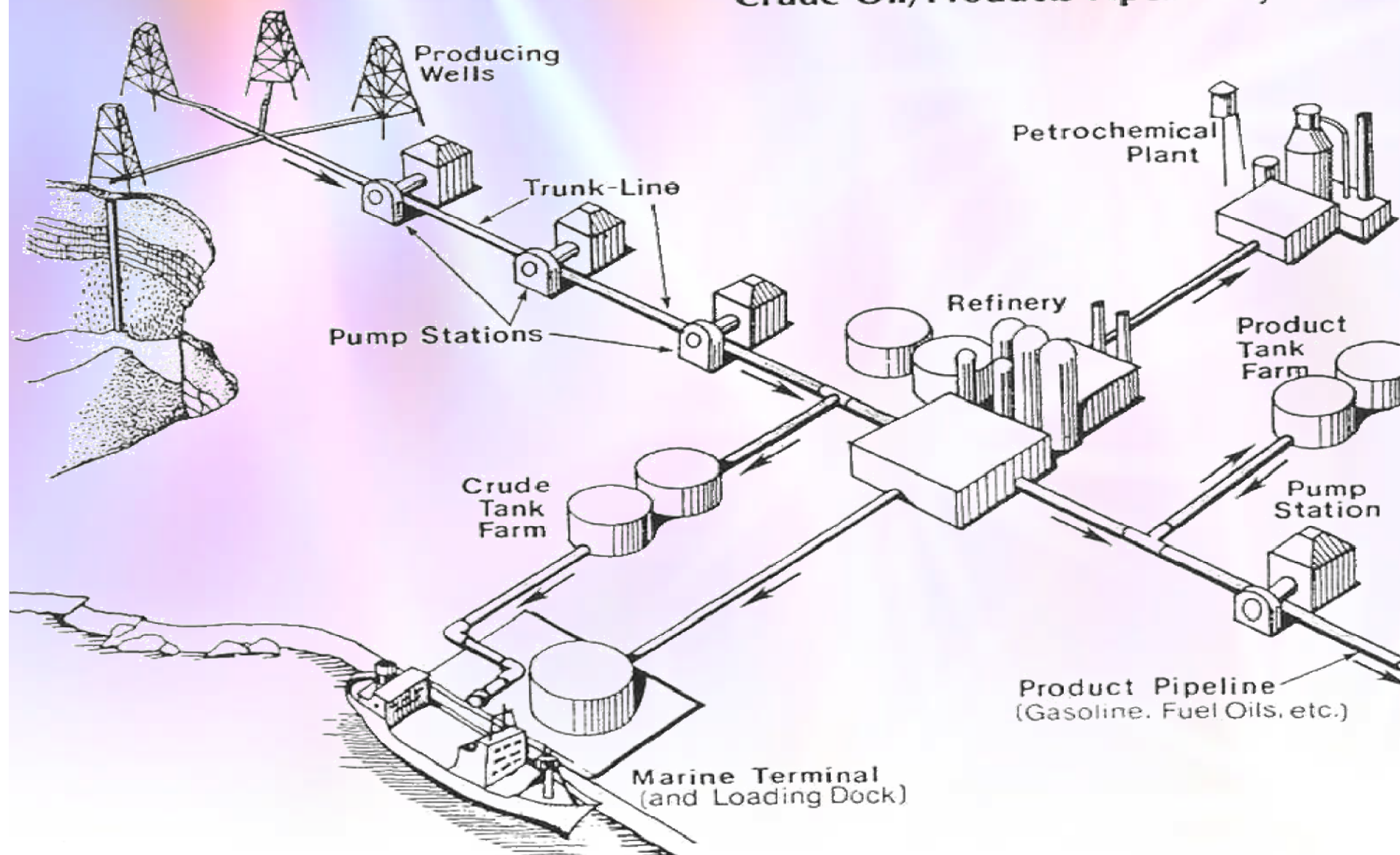
(c)

☐ (5) A low-stress pipeline on which construction was begun after **August 10, 1994.**



# Pipelines from the Well to the Refinery and Market

## Crude Oil/Products Pipeline System





# Part 195 Subpart C

Design  
Requirements



## 195.100 Scope.

This subpart prescribes minimum design requirements for *new* pipeline systems constructed with steel pipe and for *relocating, replacing, or otherwise changing* existing systems ...



# 195.401 General requirements.



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# 195.401 General requirements.



(c)

☐ (5) A low-stress pipeline on which construction was begun after **August 10, 1994.**



# 195.106 Internal design pressure.

$$P = (2 St/OD)^* \times E \times F$$

E = seam joint factor

F = design factor



\*  $2 St/O.D.$  Used to determine low stress



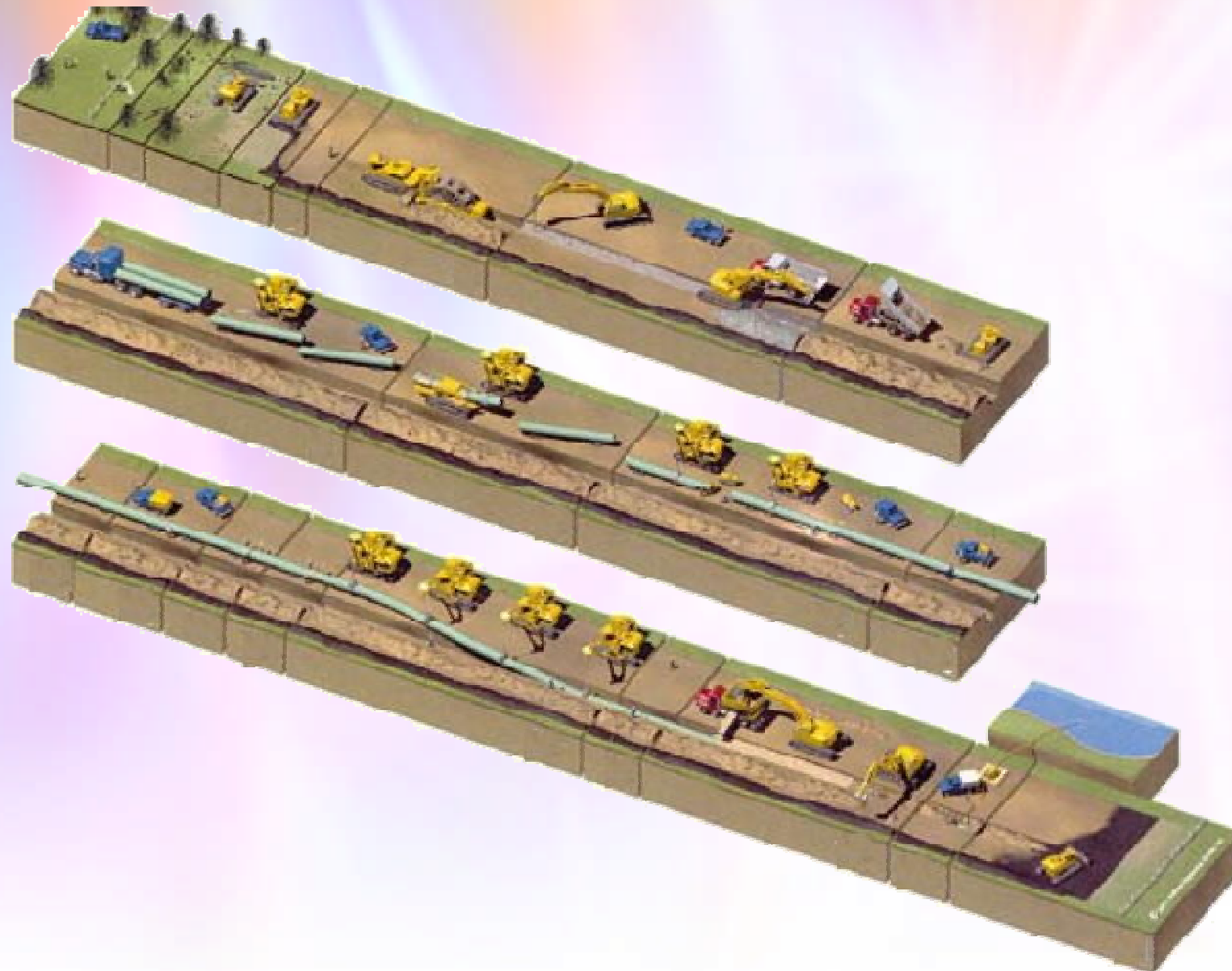
# Part 195

## Subpart D

Construction



# Pipeline Construction Sequence





## 195.200 Scope.

This subpart prescribes minimum requirements for constructing *new* pipeline systems constructed with steel pipe and for *relocating, replacing, or otherwise changing* existing systems ...



# Pipeline Construction

**1. Surveying.** The right-of-way is a narrow strip of land that contains the pipeline(s) and is where all onsite construction activities occur. After a planned or proposed route is determined, it is surveyed to determine the parameters that will be needed to complete the project.




**§195.210 Pipeline location.**





# 195.210 Pipeline location.

 **ROW must be selected to avoid, as far as practicable:**


- areas containing private dwellings
- industrial buildings
- places of public assembly







## 195.210 Pipeline location.

 **Pipeline may not be located within 50 feet of any:**

- private dwelling
- industrial building
- places of public assembly

**unless 12" of cover is added.**



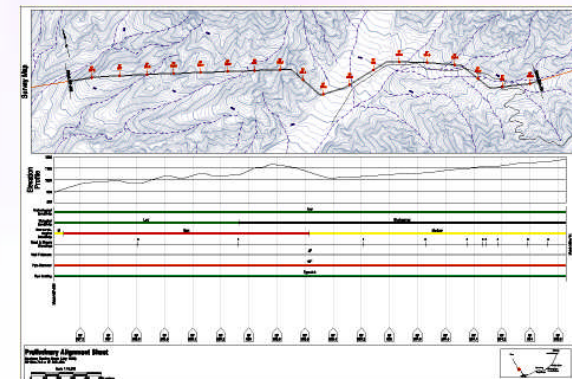
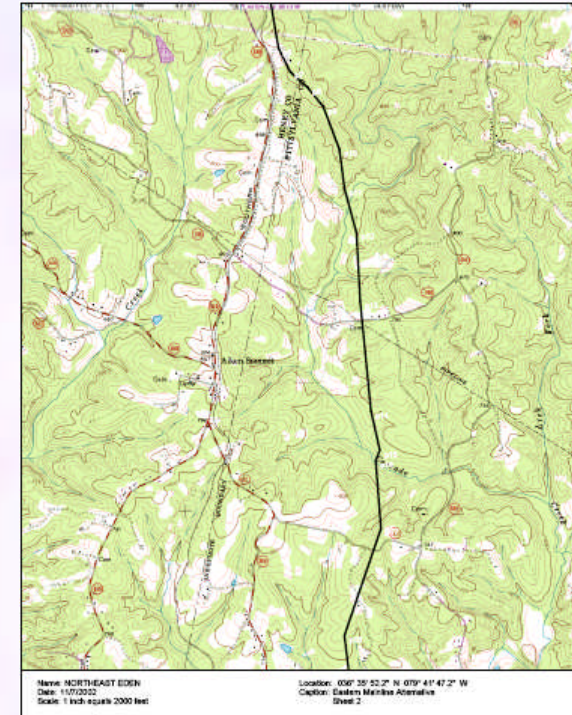
# Pipeline Construction

## 1. Maps & Materials.

Once the pipeline is surveyed, ROW is purchased, alignment sheets (maps) are drawn and material lists are generated.

**§195.202 Compliance with specifications or standards.**

**§195.206 Material inspection.**





# 195.202 Compliance with specifications or standards.



Each pipeline system must be constructed in accordance with comprehensive written specifications or standards that are consistent with the requirements of this part.







# 195.206 Material inspection.



No pipe or other component may be installed unless it has been visually inspected at site.





# Pipeline Construction

## **2. Clearing & Grubbing.**

The ROW is cleared of brush and trees, and leveled to give workers and equipment access to build, inspect and maintain the pipeline.





# Track-Type Tractor or Dozer





## 195.204 Inspection - general.

Inspection must be provided to ensure the installation of pipe or pipeline systems in accordance with the requirements of this subpart.





## 195.204 Inspection - general.

No person may be used to perform inspections unless that person has been trained and is qualified in the phase of construction to be inspected.







# Pipeline Construction

**3. Right-of-way preparation.** The right-of-way will be graded, and pads may be built to allow for the movement of ditchers, additional equipment, materials and other pipeline construction activities.





# Pipeline Construction

**4. Hauling and stringing the pipe.** Lengths of pipe are moved from stockpile sites to the right-of-way. They are lined up along the right-of-way, ready for welding.





# Stringing

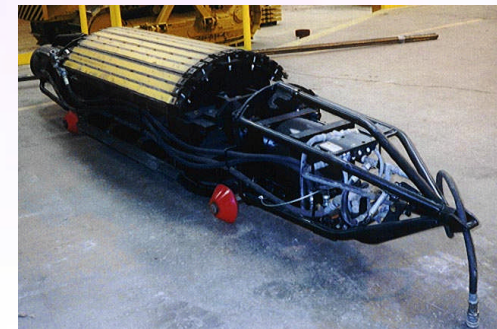
Stringing is the delivery and distribution of line pipe where it is needed on the right-of-way and when it is needed





# Pipeline Construction

**5. Bending the pipe.** A pipeline must cross over hills and curve around special places such as lakes and sacred sites. A specialized pipe-bending machine is used to bend some pipe to the shape of the land. The pipe retains its strength and remains circular where it is bent because of the characteristics of steel and the bending techniques used.





# Bending







# Hydraulic Pipe Bending Machines



## Pneumatic Bending Mandrel





# Bent to Fit

The pipe must be bent to reflect the general contours of the right-of-way.





# 195.212 Bending of pipe.



**Pipe may not have a wrinkle bend.**



**Each field bend must comply with the following:**







# 195.212 Bending of pipe.

- not impair serviceability
- have a smooth contour
- pipe with longitudinal weld, must be in neutral axis unless--

➤ made with internal mandrel

➤ pipe is  $<12''$  or has diameter to w.t. ratio  $<70$





# Pipeline Construction

**6. Welding.** A technique where another metal is melted and used to join lengths of pipe. Automatic welding machines are used where possible and some hand welding also takes place. A rigorous quality assurance and quality control program is followed to ensure the strength and quality of the welding.





# Welding



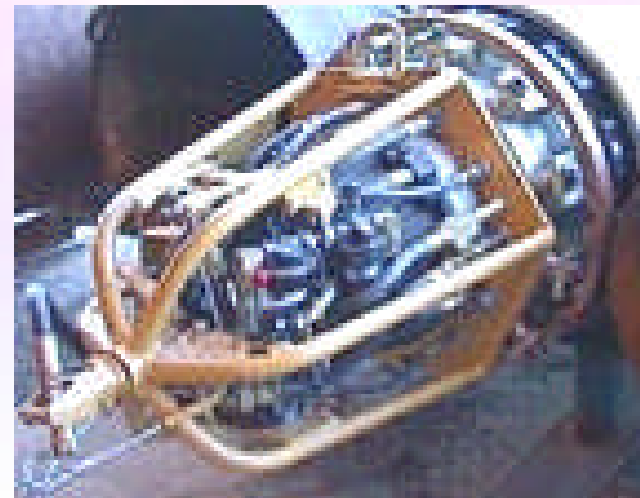


## Beveling Machine



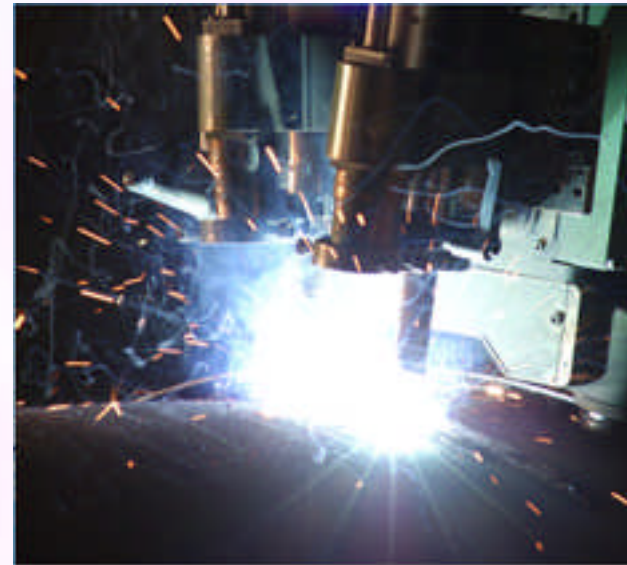
## Pneumatic Internal Lineup Clamp

## External Line-up Clamps





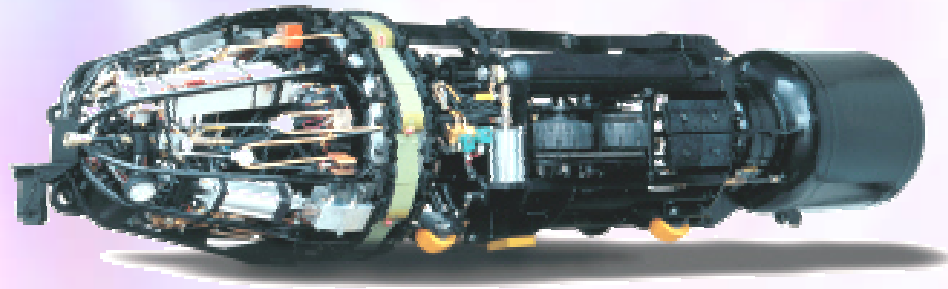
# Automatic External Welder







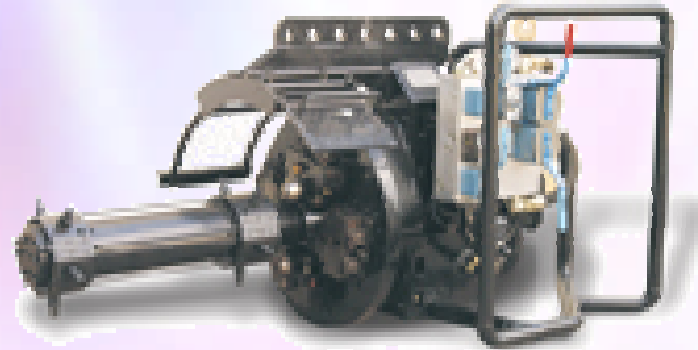
# Automatic Internal Welder







# Pipe Facing Machine



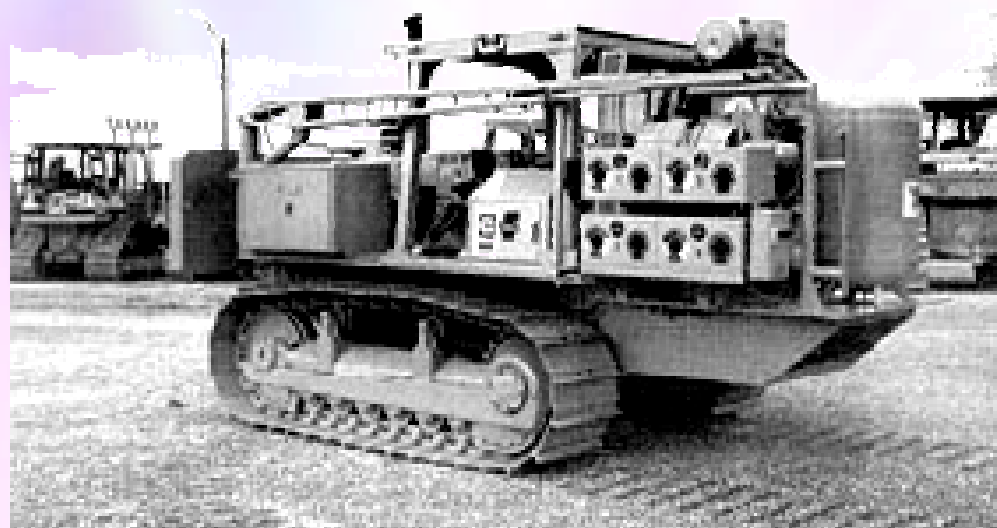


# Welding Truck Rig





# Welder Tractor







# The Pipe Gang

The workers responsible for positioning the pipe, aligning it, and making the initial welds.





# Firing Line

The workers responsible for the filler pass and the cap bead, which complete the joint







# 195.208 Welding of supports and braces.



May **NOT** be welded to pipe which operates over 100 psig.







# Good Weld?





# Radiography



195.234 Welds:  
Nondestructive testing.





# Field Joint Coating

Mill coated pipe has a cutback of 6-9 inches at the end of the pipe to not interfere with welding. This cutback must be coated once the weld is complete.

195.557 Which pipelines must have coating for external corrosion control?

195.559 What coating material may I use for external corrosion control?



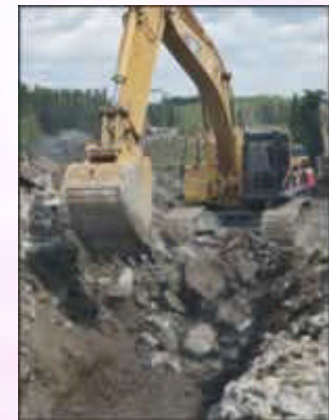
195.561 When must I inspect pipe coating used for external corrosion control?

195.581 Which pipelines must I protect against atmospheric corrosion and what coating material may I use?



# Pipeline Construction

**7. Digging the trench.** The way the trench or ditch is dug, and what equipment is used, depends mainly on the type of soil. Alternates include bucket wheel trenchers. Other digging equipment will include backhoes or trackhoes



- 195.246 Installation of pipe in a ditch.
- 195.248 Cover over buried pipeline.
- 195.250 Clearance between pipe and underground structures.







# Hydraulic Excavator or Trackhoe





# Backhoe or Rubber-Tired Hoe







# Trencher or Ditching Machine



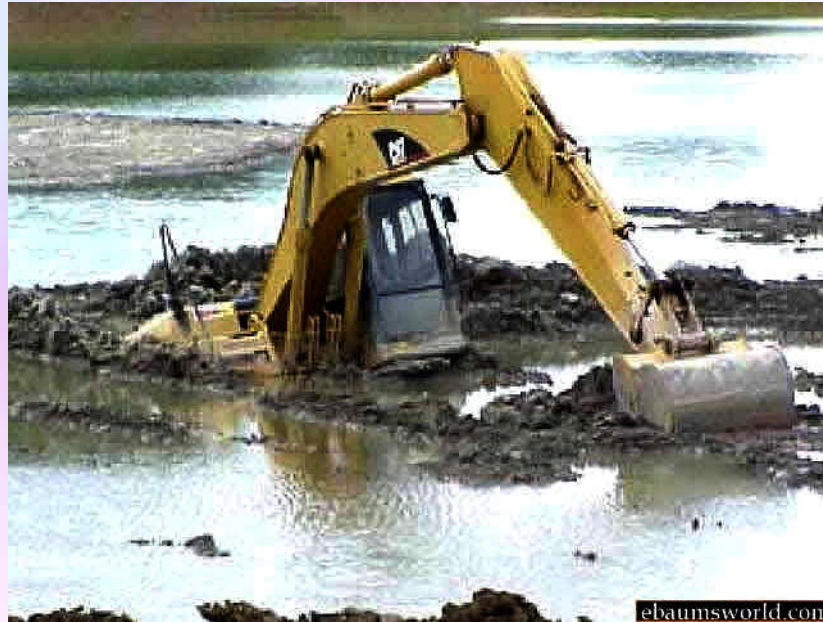


# Ditching or Trenching





# First Rule of Holes:



When you're in one ...

**STOP  
DIGGING!!!**



# Trench Boxes





# TAPS

## Trans-Alaska Pipeline System



In this case the pipeline is not lowered in-It's lowered up!

Supported aboveground by vertical support members





# Pipeline Construction

## 8. Lowering the pipe.

Tractors with special arms called sidebooms are used to lower the pipe into the trench. Care is taken to avoid damaging the pipe and its exterior coating.



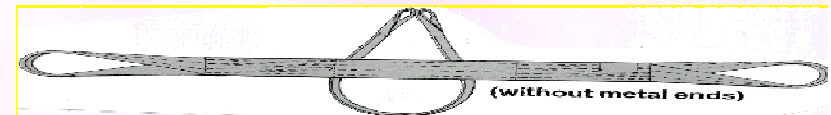
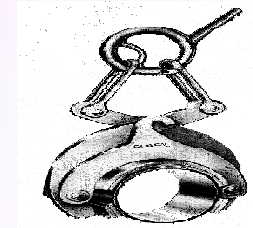
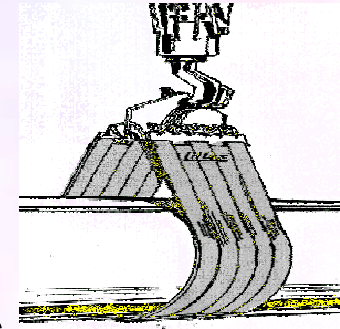




# Pipeline Construction

## 8. Lowering the pipe.

Different tools are used to help facilitate the lowering in process. These include slings, rollers, cradles and pipe tongs. As the pipe is lowered in, a holiday detector or “jeep” is used to locate voids in the coating.





# Pipelayer or Sideboom





# Lowering In



- 195.246 Installation of pipe in a ditch.
- 195.248 Cover over buried pipeline.
- 195.250 Clearance between pipe and underground structures.





# Fabrication

**9. Installing valves and special fittings.** Valves and other connections are part of a pipeline. These assemblies are installed as the pipeline is constructed. They include shut-off valves that can block off sections of the pipeline for maintenance.



- 195.254 Aboveground components.
- 195.256 Crossing of railroads and highways.
- 195.258 Valves: General.
- 195.260 Valves: Location.





# Pipeline Construction

**10. Crossings.** A pipeline will need to cross rivers and streams, roads, railroads and other pipelines. Plans are developed in advance. Water crossings can be completed either by "open cut" techniques or by horizontal directional drilling.







# Pipeline Construction

## **10. Crossings. (CONTINUED)**

The selection of a crossing method depends upon site specific criteria such as fish habitat, water flow, and soil conditions such as rocks and boulders. Generally, horizontal directional drilling is selected for major river crossings where local soil conditions permit the technique.



195.256 Crossing of railroads and highways.



# Boring Machine



# Directional Drilling Machine







# Horizontal Drilling Rig



## STAGE 1: PILOT HOLE DIRECTIONAL DRILLING

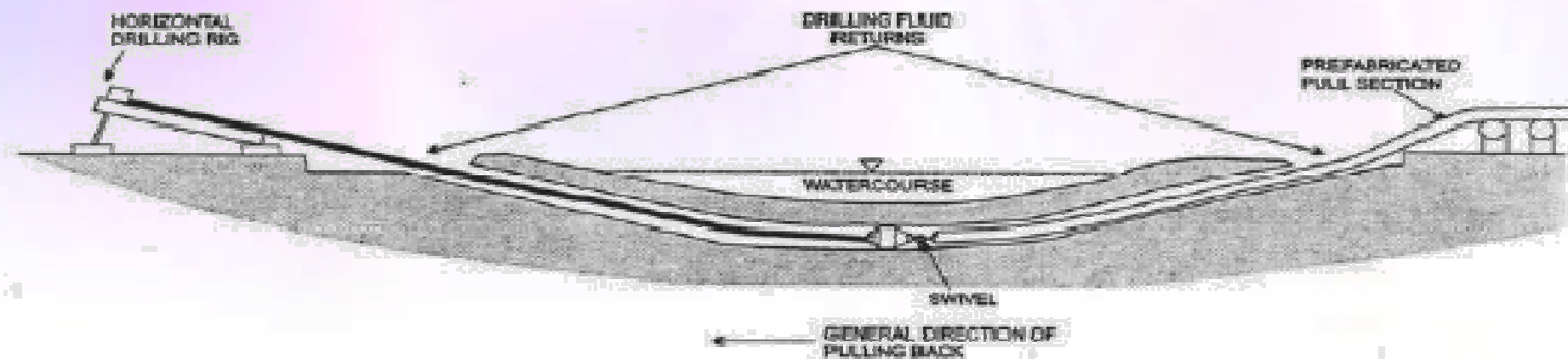
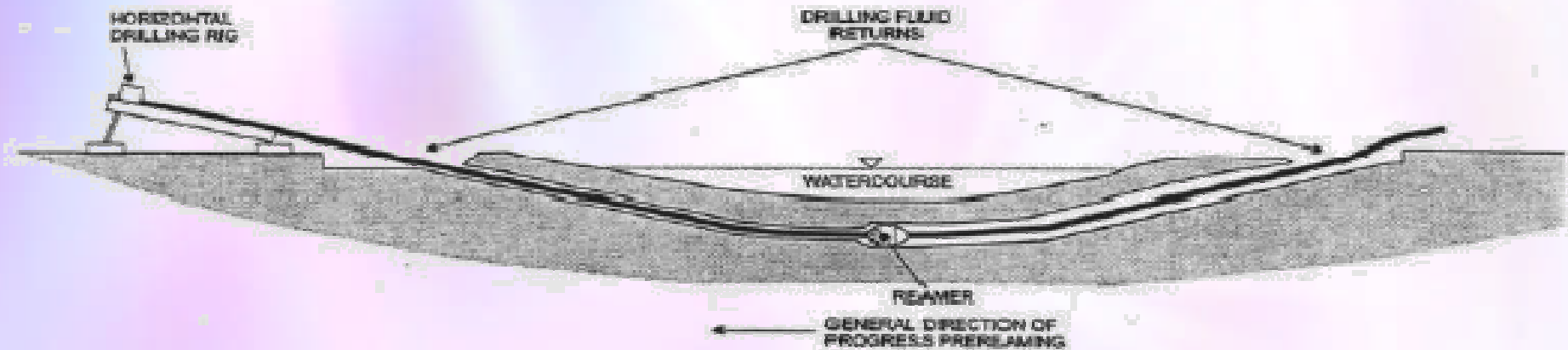


HORIZONTAL  
DRILLING RIG

# Directional Drilling



## STAGE 2: REAMING AND PULLING BACK





# Pipeline Construction

## **11. Backfilling the trench.**

Before testing the pipeline, the ditch is backfilled. Sometimes the excavated soil is used to fill the trench and sometimes other selected backfill is used. Care is taken to protect the pipe coating from potential damage.



195.252 Backfilling.





# Backfilling





# Track-Type Tractor or Dozer



Padding Machine



# Tie-In

**12. Tie-in.** Collective term for the construction tasks bypassed by regular crews on pipeline construction. Tie-in includes welding road and river crossing, valves, portions of the pipeline left disconnected for hydrostatic testing, and other fabrication assemblies, as well as taping and coating the welds.





# Pipeline Construction

**13. Testing.** A variety of methods will be used to ensure the integrity of the assembled pipeline and to comply with code.

195.304 Test pressure.

195.305 Testing of components.

195.307 Pressure testing aboveground breakout tanks.

195.306 Test medium.

195.308 Testing of tie-ins.

195.310 Records.







# Pipeline Construction

**14. Dewatering.** If water is used as a test medium, dewatering of the pipeline is done with dewatering pigs. The water should be disposed of in an environmentally sensitive manner.







# Pipeline Construction

**15. Cleaning up.** The pipeline right-of-way and temporary facilities such as camps will be reclaimed.



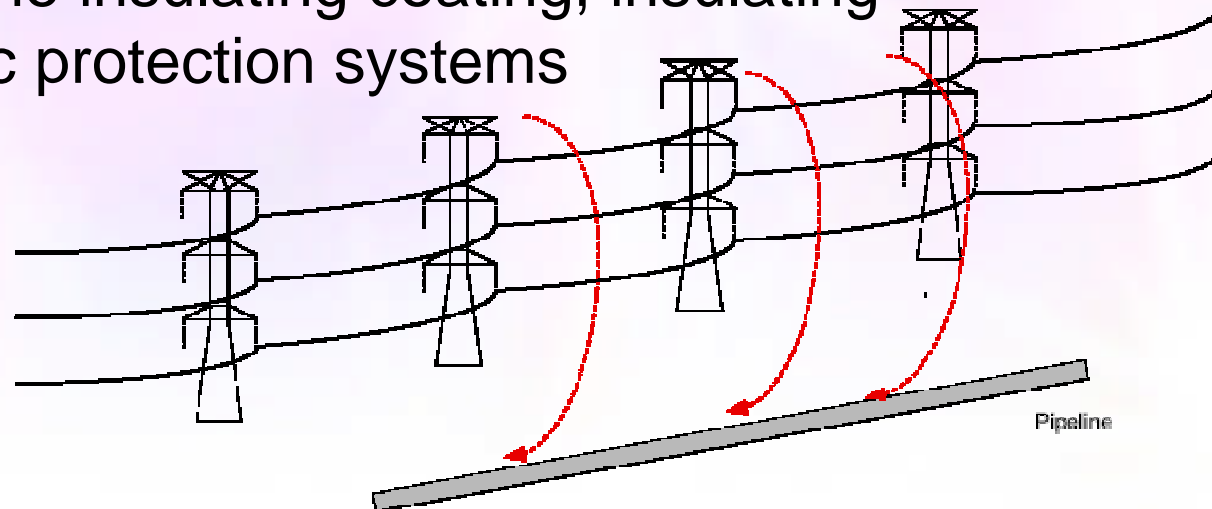


# Electromagnetic Interactions Between Power Transmission Lines and Pipelines



The continuous growth of energy consumption and the difficulties in establishing new ROW's for transmission power lines and metal pipelines increase the tendency to site them along the same routes. Consequently, electromagnetic problems can arise.

- Electric shocks to people who contact the pipeline
- Damage to pipeline insulating coating, insulating joints and cathodic protection systems





# Electromagnetic Interactions Emission



Induced voltages can be produced through capacitive, inductive and conductive couplings with the power line



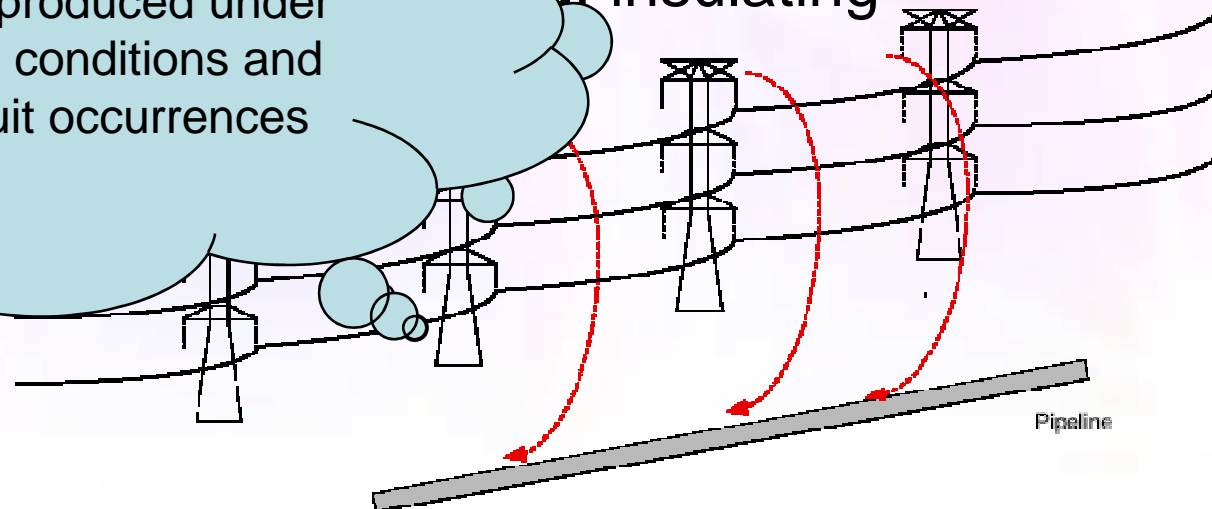
The continuous growth of energy in establishing new ROW's pipelines increase the total routes. Consequently, electric

Intensity depends on the power line, pipeline and soil characteristics... and geometric configuration between the power line and the pipeline.

- Electric shocks to people who come in contact with

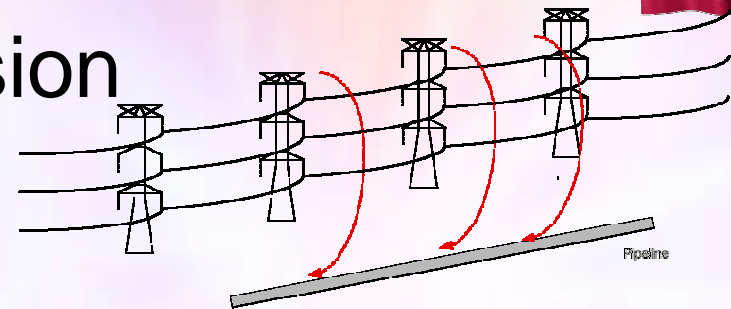
- Damage to equipment and insulating

Voltages can be produced under normal operating conditions and during short-circuit occurrences at the power line





# Electromagnetic Interactions Between Power Transmission Lines and Pipelines



- Pipeline induced voltages should be compared to safety limits established by industry codes.
- Underground sections of pipeline checked with respect to the risks of damage to pipeline coating.
- Above-ground sections checked for risks of potential electric shocks to people.
- Voltage across insulating joints compared to the voltage withstand capability.
- Cathodic protection systems checked for maximum voltages at their connection to the pipeline.



# Other Safety Considerations

- When driving on the Right-of-Way - watch out for **HEAVY EQUIPMENT!**







# Other Safety Considerations

Wild animals are about in the woods – be careful!





# Other Safety Considerations

- Overhead power lines and equipment-don't be in contact with equipment or stand near (water, mud other conductors)
- Wear proper personal protective equipment
- Beware of lengths of welded pipe on skids without proper cribbing
- Don't stand near pipe being lifted from ground
- Don't stand near pipe truck being unloaded
  - Note improperly chocked pipe



# Other Safety Considerations

- Sideboom A-frames don't fall up
- Sidebooms can flip over when lifting pipe
- Sidebooms can roll over backward on an incline
- Be aware of worn cables or slings
- Hydraulic hoses can break causing unintended equipment movement

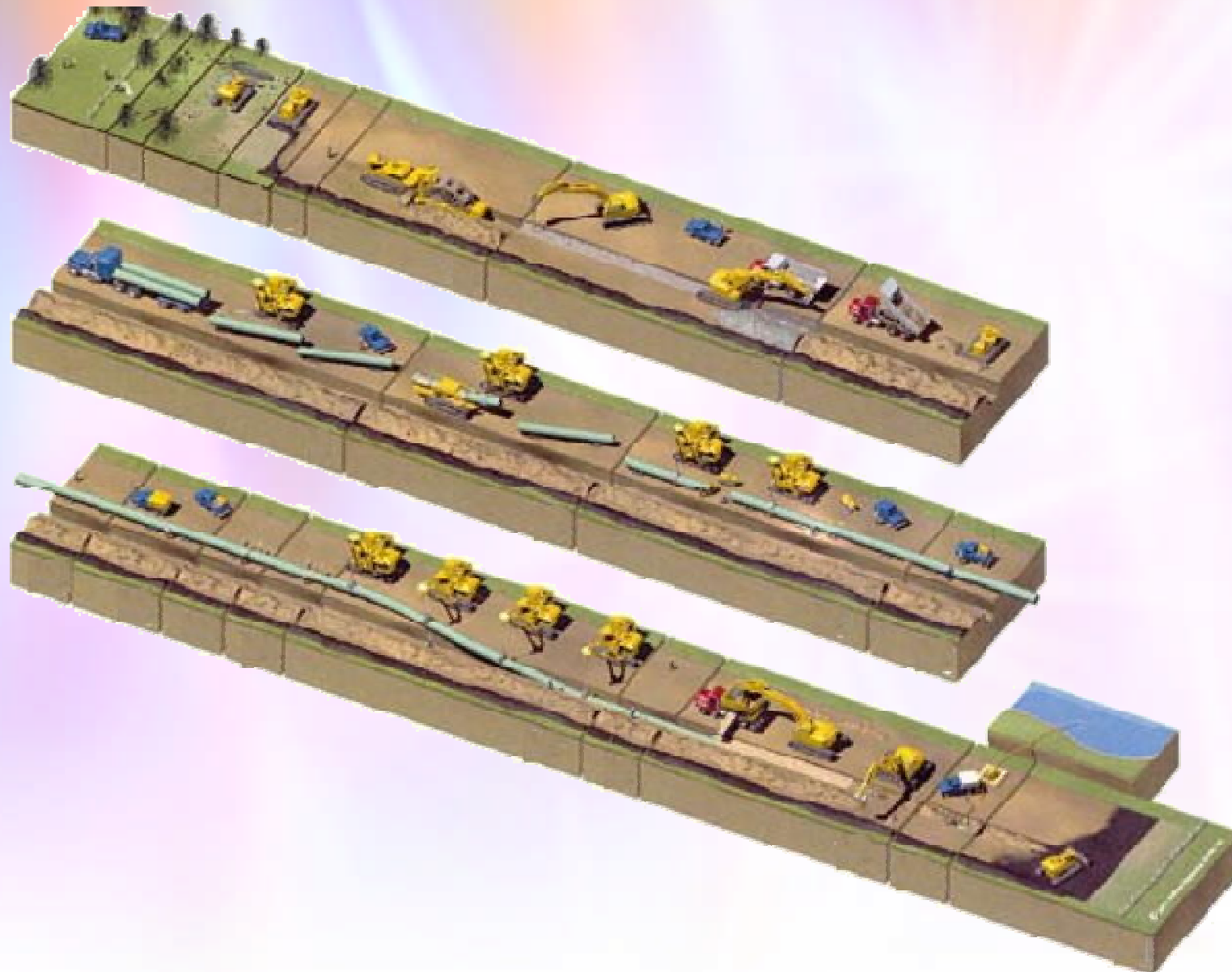


# Other Safety Considerations

- Be aware of trenching and shoring safety precautions
  - Don't stand near the edge of an excavation
  - Don't enter an unsafe excavation
  - Equipment vibrations can cause a cave-in
- Welding can cause a "flash"
  - Welding at night near glass can reflect the same damaging radiation
- Avoid touching the "tail" of the "jeep"



# Pipeline Construction Sequence







- Construction spreads - what's going on during construction:
- Surveying, staking & pre-construction condition documentation
- Environmental Mitigation
- Relocation/replacement – precautions near/over live lines
- Clearing, stumping, grubbing & grading
- Stringing & bending
- Welding & Coating
- Trenching, double ditching/HDD & bores
- Road and stream x-ings (rip-rap, flume & trench, etc.,)
- Lowering-in
- Tie-ins
- catheading
- Coatings, corrosion & backfill
- Hydro (pre & post testing), de-water, clean & dry
- ♦ Purging
- Commissioning
- ♦ Hot taps & stopples
- Final clean-up